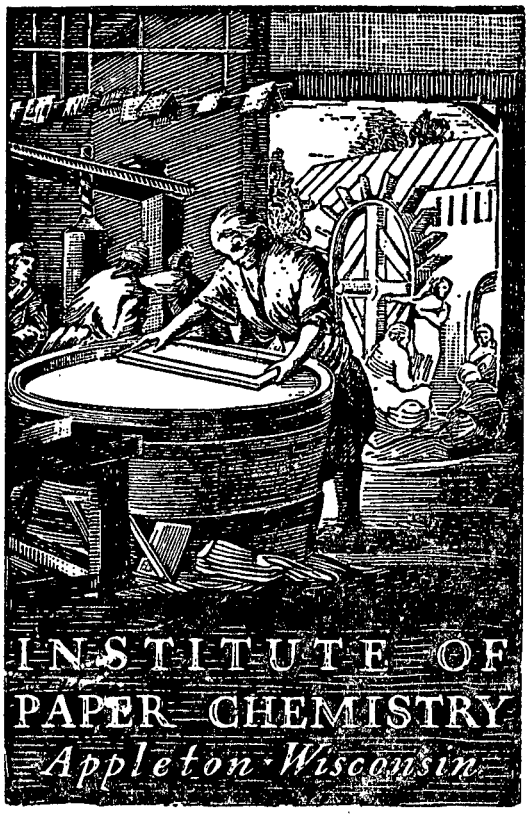

EQUILIBRIUM MOISTURE CONTENT OF SACK PAPER

Project 2033

Progress Report Two

to

MULTIWALL SHIPPING SACK PAPER MANUFACTURERS

October 1, 1958

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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SUMMARY

In response to inquiries regarding the equilibrium moisture contents at 50% R.H. and 73°F. of the sack paper collected for the recent fabrication run, a study was performed using samples from 20 of the rolls. An over-all average moisture content near 7.3% was obtained with a range in average results running from 6.9 to 7.9% moisture.

INTRODUCTION

As is well-known, nearly all physical properties of paper are profoundly influenced by moisture content. The moisture content of a given paper depends upon both the relative humidity and temperature with which the paper is in equilibrium. More exactly, the moisture content of a given paper depends not only on the relative humidity and temperature but also on the direction of change of the moisture content in arriving at the equilibrium moisture content. For example, if specimens of a given paper having low and high moisture contents are exposed to an atmosphere of 50% R.H., appreciably different equilibrium moisture contents will be obtained. It is for this reason that the physical characteristics of a sheet are customarily determined after exposing the sheet to first a low relative humidity and then to the conditioning atmosphere (1).

Although a few investigators such as Campbell (2) indicate that the moisture content of paper is independent of the furnish and kind of paper, most workers in the field are of the opinion that moisture content

of a sheet is dependent not only on ambient relative humidity and temperature, but also on the nature of the material. Thus, the hygroscopicity of fibrous materials such as paper is probably related to the wood species, type and degree of cooking, washing, drying, etc.

In discussing the preliminary results obtained in evaluating the physical characteristics of the rolls collected at the fabrication run, some questions were raised regarding the equilibrium moisture contents of the various roll samples. In order to illustrate the range of moisture contents characteristic of samples from such diverse sources, equilibrium moisture contents at 50% R.H. and 73°F. were determined for 20 of the fabrication roll samples. The results are reported herein.

MATERIALS

The materials for this study consisted of samples taken from 20 of the rolls of 50-lb. sack paper used in the March fabrication run. The roll samples selected were those used in forming the middle ply of the sewn and pasted sacks. At the time of fabrication, samples were taken from each of the rolls at the following times:

(1) Start--sewn sacks

(2) End -- sewn and start--pasted sacks

(3) End -- pasted sacks

All specimens used in this study were cut from the sack paper samples taken at the fabrication run.

PROCEDURE

In performing this study, it was considered desirable to minimize the effect on equilibrium moisture content, minor though it might be, of small fluctuations in temperature and relative humidity within the conditioned enclosure. Although all samples were conditioned in an atmosphere maintained at 50 ± 2% R.H. and 73° ± 3.5°F., it should be pointed out that the specified tolerance permits a slight variation in the moisture content. For example, the highest moisture conditions within the above tolerance would exist when the relative humidity is 52% and the temperature 69.5°F. Similarly, the driest condition would exist with a relative humidity of 48% and a temperature of 76.5°F. The extreme relative humidity and temperature changes permissible within the tolerance probably would correspond to a change of approximately ± 0.2 in the percent moisture content. Thus, if by chance two samples were evaluated--one in equilibrium with the driest condition and the other in equilibrium with the more humid condition--an apparent difference in equilibrium moisture content of the two samples as great as 0.4% moisture content might be obtained merely because of the difference in test conditions.

The above considerations indicated that a more reliable comparison of the equilibrium moisture contents of the 20 samples could be obtained if (1) all specimens were exposed to essentially the same atmosphere, and (2) the conditioned weight of all specimens could be determined simultaneously. While the above conditions are impossible of attainment, the procedure described below was employed in an effort to approach the "ideal" conditions.

1. Three 4 x 12-inch specimens were cut at each roll sampling location (start-sewn; end-sewn; and end-pasted) giving nine specimens per roll. (Note: This was true for all rolls except for those rolls which arrived too late to be fabricated into sewn sacks; only six specimens were evaluated in their case.)

2. After the specimens were cut, they were segregated into three sets representing start-sewn, end-sewn and end-pasted specimens.

3. The approximately 60 specimens in each set were shuffled together and all specimens for a given set were hung on one conditioning rod. The three conditioning rods were then placed on one conditioning rack. All specimens were located quite close to each other physically and therefore would be exposed to air having essentially the same relative humidity and temperature.

4. At the end of the conditioning period, each specimen was sealed into a plastic envelope with low moisture vapor transmission characteristics. Rubber gloves were used in handling the specimens and care was taken to avoid breathing on the materials. Sealing was done quite quickly--10 to 15 minutes being required for the approximately 60 specimens on each conditioning rod.

5. After exposing the sealed plastic envelopes to the conditioning atmosphere for 24 hours to normalize their moisture content, moisture content determinations were performed in the usual manner by obtaining

the weight of the sealed envelope, the empty envelope and the ovendry weight of the specimen. The ovendry weight was obtained using a hot balance after drying the specimens for at least 16 hours at 100 to 105°C.

Moisture contents were computed on the ovendry basis.

DISCUSSION OF RESULTS

The results obtained are summarized in Table I where the first three columns represent the average of three specimens while the composite average includes results from nine specimens. The individual test results are tabulated in Table I-A of the Appendix.

In Table I it may be noted that the composite average moisture contents range from 6.9 to 7.9% moisture--a spread of 1%. The over-all average moisture content for all samples was near 7.3%. The magnitude of the differences bears out earlier remarks regarding the dependence of equilibrium moisture content on the nature of the various samples. In other words, it appears that, under the same atmospheric conditions, certain of the samples were of such a nature that they adsorbed a greater amount of moisture than did other samples. Such differences in hygroscopicity are probably related to the differing wood species, type and degree of working, washing, previous moisture history, etc., used in manufacture.

TABLE I

EQUILIBRIUM MOISTURE CONTENTS OF 50-LB. SACK PAPER FROM VARIOUS MILLS

Roll No.	Start-Sewn	End-Sewn and Start-Pasted	End-Pasted	Composite Average
120	7.3	7.1	7.4	7.3
121	7.6	7.5	7.4	7.5
122	7.9	8.0	7.7	7.9
123	7.7	7.8	7.7	7.7
124	7.1	6.8	6.9	6.9
125	7.3	6.9	7.4	7.2
126	7.9	7.8	8.0	7.9
127	6.8	7.4	7.5	7.2
128	7.4	7.3	7.0	7.2
129	7.5	7.1	7.5	7.4
130	7.7	7.8	7.4	7.6
131	7.6	7.1	7.0	7.2
132	7.5	7.2	7.3	7.3
133	7.1	7.2	7.2	7.2
134	7.0	6.9	7.1	7.0
135	7.4	7.1	7.4	7.3
136	7.1	7.1	7.1	7.1
137	---	7.4	7.7	7.6
138	---	7.0	7.2	7.1
139	---	7.3	7.3	7.3

LITERATURE CITED

1. Institute of Paper Chemistry. Paper Trade J. 104, no. 15:45-8 (April 15, 1937).

2. Campbell, Ross. Paper Trade J. 73, no. 2:30, 32, 34 (July 14, 1921).

THE INSTITUTE OF PAPER CHEMISTRY

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TABLE I-A

INDIVIDUAL TEST RESULTS

Moisture Content, %

Roll No.	Start--Sewn Sacks				End Sewn and Start Pasted Sacks				End--Pasted Sacks				Grand Average
	Spec. 1	Spec. 2	Spec. 3	Average	Spec. 1	Spec. 2	Spec. 3	Average	Spec. 1	Spec. 2	Spec. 3	Average	
120	7.41	7.20	7.39	7.3	7.18	7.00	7.14	7.1	7.36	7.33	7.46	7.4	7.3
121	7.39	7.76	7.79	7.6	7.58	7.29	7.49	7.5	7.53	7.35	7.41	7.4	7.5
122	8.06	7.66	7.90	7.9	7.92	7.88	8.06	8.0	7.63	7.68	7.79	7.7	7.9
123	7.64	7.69	7.71	7.7	7.86	7.88	7.79	7.8	7.51	7.93	7.73	7.7	7.7
124	7.35	6.89	7.01	7.1	6.85	6.76	6.75	6.8	7.05	6.84	6.90	6.9	6.9
125	7.43	7.19	7 35	7.3	6.90	6.75	7.19	6.9	7.25	7.50	7.50	7.4	7.2
126	7.94	8.03	7.61	7.9	7.96	7.78	7.80	7.8	8.14	7.98	8.03	8.0	7.9
127	6.59	6.82	6.87	6.8	7.44	7.38	7.46	7.4	7.40	7.60	7.63	7.5	7.2
128	7.36	7.51	7.36	7.4	7.40	7.20	7.34	7.3	6.91	6.96	7.12	7.0	7.2
129	7.49	7.40	7.56	7.5	7.01	7.10	7.25	7.1	7.63	7.29	7.55	7.5	7.4
130	7.61	7.74	7.75	7.7	7.70	7.78	7.89	7.8	8.01	7.83	6.28	7.4	7.6
131	7.74	7.46	7.64	7.6	7.04	7.10	7.24	7.1	6.93	6.96	7.10	7.0	7.2
132	7.64	7.35	7.59	7.5	7.29	7.24	7.16	7.2	7.15	7.22	7.39	7.3	7.3
133	7.15	7.10	7.00	7.1	7.04	7.32	7.28	7.2	7.27	7.17	7.21	7.2	7.2
134	7.03	6.96	7.06	7.0	6.89	6.86	6.96	6.9	7.19	6.92	7.16	7.1	7.0
135	7.39	7.43	7.39	7.4	7.44	7.11	6.87	7.1	7.33	7.25	7.47	7.4	7.3
136	7.21	6.96	7.18	7.1	7.25	7.02	7.17	7.1	7.05	7.06	7.27	7.1	7.1
137					7.61	7.28	7.42	7.4	7.77	7.51	7.79	7.7	7.6
138					6.96	7.05	7.05	7.0	7.03	7.37	7.23	7.2	7.1
139					7.44	7.20	7.37	7.3	7.34	7.27	7.21	7.3	7.3